FOOD AND DIEL FEEDING PERIODICITY OF JUVENILE SICKLEFIN MULLET, *LIZA FALCIPINNIS* (MUGILIDAE) IN A 'CLOSED' TROPICAL LAGOON

by

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ABSTRACT. - Juvenile sicklefin mullet, *Liza falcipinnis* (Cuvier and Valenciennes, 1836) in the 'closed' Fosu Lagoon (5°07'N, 1°16'W), Ghana, fed on a wide range of food items mainly diatoms, green algae, ostracods, and particulate organic and inorganic matter. The fish filtered sand particles in the size range 10-650 µm, but those measuring 50-100 µm were the most predominant. The relative gut length (intestine length to standard length ratio) ranged from 2.2-5.1. Both relative gut length and diet did not change significantly with size of fish. The species showed a diurnal feeding habit, and the peak feeding at 10.00 or 14.00 h on different days may be ascribed to the increase in light intensity at these times.

RÉSUMÉ. - Les juvéniles de *Liza falcipinnis* (Cuvier & Valenciennes) du lagon Fosu fermé (5°07'N, 1°16'W), au Ghana, se nourrissent d'une grande variété d'aliments, principalement de diatomées, d'algues vertes, d'ostracodes, et de particules organiques et inorganiques. Ce poisson filtre les particules du sable d'une taille allant de 10 à 650 µm, mais celles qui mesurent entre 50 et 100 µm sont les plus nombreuses. La longueur relative de l'intestin (rapport de la longueur de l'intestin sur la longueur standard) varie de 2,2 à 5,1. La longueur relative de l'intestin et le régime alimentaire ne changent pas significativement en fonction de la taille du poisson. *Liza falcipinnis* a des habitudes alimentaires diurnes et l'activité alimentaire maximale observée à 10 ou 14 h à des jours différents peut être reliée à l'augmentation de l'intensité lumineuse à ce moment de la journée.

Key-words. - Mugilidae, *Liza falcipinnis*, Ghana, Fosu Lagoon, Food, Diel feeding activity.

Of the mugilids found in the coastal waters of West Africa, the sicklefin mullet, *Liza falcipinnis* (Cuvier & Valenciennes, 1836) is reportedly the most common (Gras, 1961; Daget and Iltis, 1965). It is considered a suitable candidate for aquaculture in the sub-region due to its wide salinity tolerance and ready availability for stocking (Payne, 1976).

Juvenile mullets enter estuaries and many lagoons in Ghana to feed. Lagoons provide shelter and fertile feeding grounds for the young of several marine fishes. In Ghana, young mullets enter 'closed' lagoons when the sand barrier is scoured by floods or human activity. Fish may also be washed into the lagoon at high spring tides.

The food and feeding habits of mullets have been investigated in some parts of West Africa (Fagade and Olaniyan, 1973; Brulhet, 1975; Payne, 1976; Albaret and Legendre, 1985). Recently, Blay (1995) examined the food and feeding activity of mullets in the Elmina Lagoon (Ghana). However, there is no information on the biology of mullets in 'closed' lagoons in West Africa. The present study deals with the food habits and diel feeding activity of juvenile *L. falcipinnis* trapped in one such lagoon.

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MATERIALS AND METHODS

Samples of *Liza falcipinnis* were collected each month from the cast-net fishery of the Fosu Lagoon (5°07'N, 1°16'W), Ghana, between September 1991 and July 1992. The principal features of the lagoon and its fishery are described in Blay and Asabere-Ameyaw (1993). Fish samples were preserved in 10% formalin for stomach content analysis.

To determine the daily feeding pattern of the species, a team of fishermen was engaged in fishing on three 24 h occasions: 12-13 and 18-19 October, and 8-9 November 1991. Fish were netted at 4 h intervals within a 15-30 min duration. Fishing commenced at 06.00, 10.00, 14.00, 18.00, 22.00 and 02.00 hours local time. Fish were preserved in 10% formalin immediately after capture. In the laboratory, the total and standard lengths were measured to the nearest 0.1 cm; fish were weighed to the nearest 0.1 g. The intestine length was measured to the nearest 0.1 cm. All morphometric data and weights were taken within 24 h of sampling in order to minimize shrinkage and dehydration by the preservative. Points were awarded to each stomach according to its degree of fullness using an arbitrary 5-point scale: 20, 15, 10, 5, and 2.5 points respectively for full, 3/4, 1/2, 1/4 and 1/8 full stomach (Blay and Eyeson, 1982). The food was weighed to the nearest 0.01 g and, subsequently, the components were identified with the aid of a microscope. Random measurements of the longest axis of sand particles and ostracods occurring in the stomach were made using an eyepiece micrometer. Further analysis of the diet was undertaken to assess the percentage composition and frequency of occurrence of the food items (Hynes, 1950).

Feeding intensity was investigated using the index of stomach fullness (Hureau, 1966) expressed as total weight of stomach contents / total fish weight x 100.

The diel feeding periodicity was based on fluctuations in the mean index of stomach fullness determined for the different sampling times during each 24 h period.

RESULTS

Specimens of *Liza falcipinnis* sampled from the Fosu Lagoon had total lengths of 7.7-18.2 cm. Of the 355 fishes examined, only 23 (approximately 7%) with total lengths above 15.0 cm showed developing gonads, hence a greater majority of individuals were presumed to be juveniles.

The ratio of intestine length to standard length (relative gut length) of 223 individuals ranged from 2.2-5.1. The relationship between relative gut length and standard length of the fishes is described by the equation:

$$Y = 4979 - 0.1197\ SL\ (r = -0.3279,\ P > 0.05)$$

where Y is the relative gut length and SL, the standard length in centimetres (Fig. 1). This indicates that no significant change in the relative gut length occurred with standard length of the fish.

Food habits

A total of 355 stomachs were examined of which 109 were empty, but there were no signs of regurgitation of food. The quantity of food varied from 0.03 to 3.79% of the weight of fish, with an average of 0.46%. There were no appreciable changes in the spectrum of food items consumed with size of fish (Table I), nor were there significant temporal variations in the composition of the food. Consequently, the data for the different monthly samples were pooled, and the results are presented in figure 2.

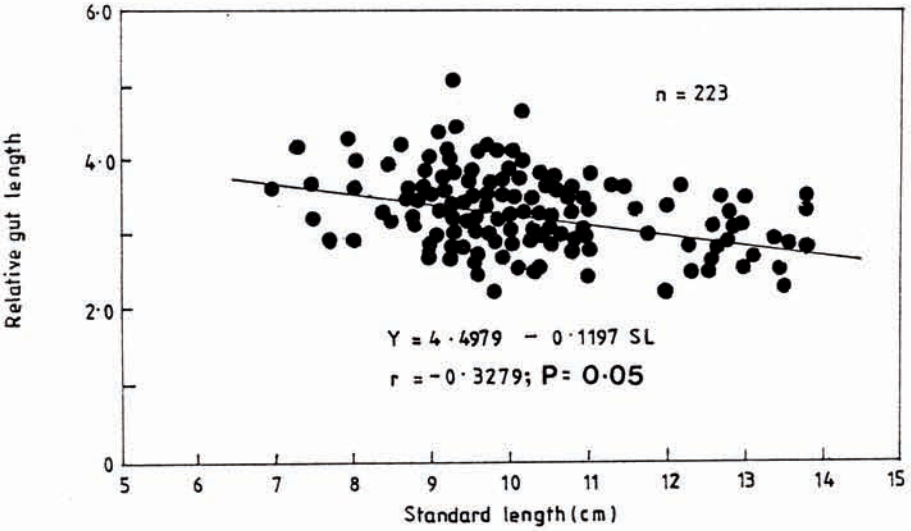

Fig. 1. - Relationship between relative gut length (intestine length/standard length) and standard length of juvenile *Liza falcipinnis*. n = number of fish examined.

Table I. - Food items in the stomachs of different size groups of *Liza falcipinnis* in the Fosu Lagoon (B = meiobenthos[a]; Bm = microbenthos[b]/inorganic material; M = vertically migrating zooplankton; P = plankton). [a] Meiobenthos = benthic organisms measuring 0.5-1.0 mm; [b] Microbenthos = benthic organisms smaller than 0.1 mm.

Food item	Size group			
	7.0-9.9	10.0-12.9	13.0-15.9	16.0-18.9
Bacteria (Bm)	+	+	+	+
Fungi (Bm)	-	+	+	+
Blue-green algae (Bm)	+	+	+	+
Diatoms (Bm)	+	+	+	+
Green algae (Bm)	+	+	+	+
Macrophyte fragments (Bm)	-	+	+	+
Protozoa (Bm)	+	+	+	+
Coelenterate bracts	+	-	+	+
Nematodes (B)	-	+	+	+
Rotifers (Bm)	+	+	+	+
Cladocerans (P)	-	+	+	+
Ostracods (M)	+	+	+	+
Copepods (M)	+	+	+	+
Crustacean parts (Bm)	+	+	+	+
Crustacean eggs (P)	+	+	+	+
Crustacean larvae (P)	+	+	+	+
Echinoderm larvae (P)	+	-	-	-
Particulate organic matter (Bm)	+	+	+	+
Sand particles	+	+	+	+

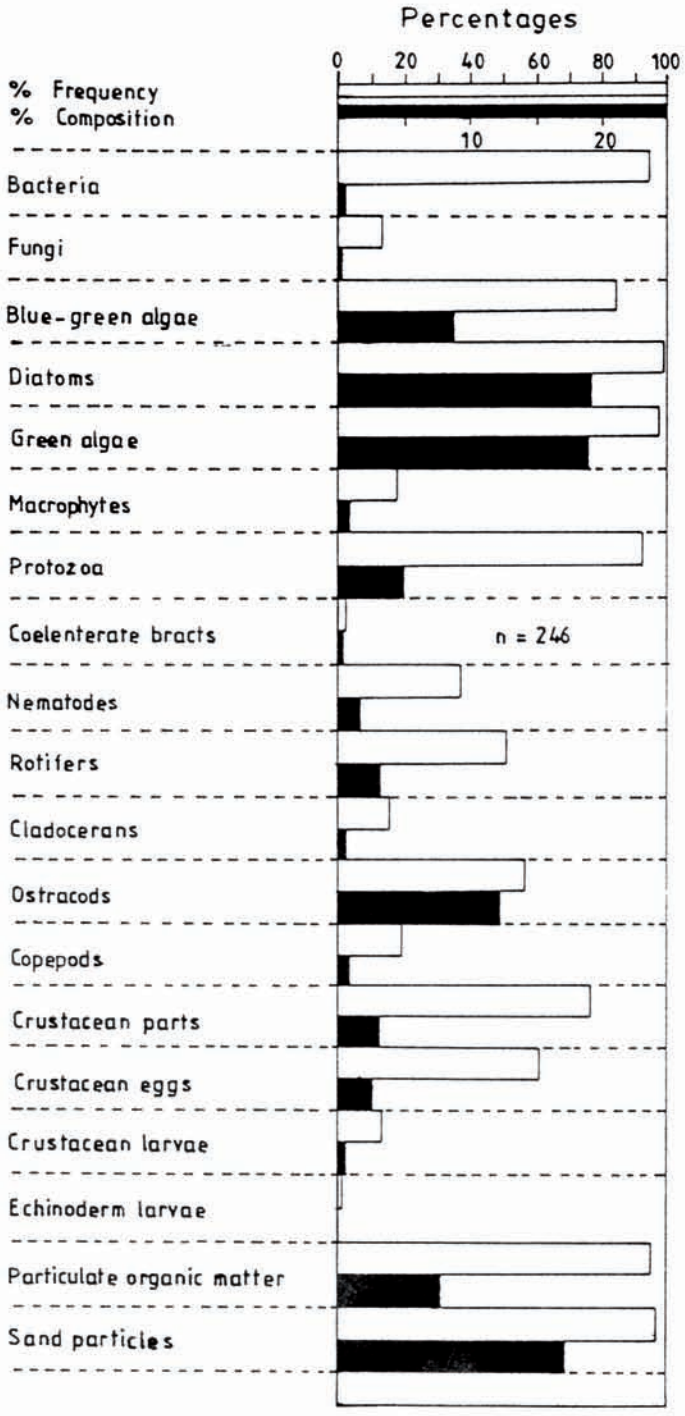

Fig. 2. - Percentage composition (■) and percentage frequency of occurrence (❑) of food items in the stomachs of juvenile *Liza falcipinnis*. n = number of fish stomachs with food.

The percentage frequency shows that diatoms, green algae, sand particles, particulate organic matter, bacteria, protozoan flagellates and blue-green algae were the most frequently eaten, occurring in 84.8-99.5% of the stomachs. Crustacean parts and eggs, ostracods, and rotifers also occurred fairly frequently in the food (50.3-76.4%). Lower frequencies (0.5-37.2%) were recorded for fungi, fragments of macrophytes, coelenterate bracts, nematodes, cladocerans, copepods and larvae of crustaceans and echinoderms.

Based on their percentage composition in the diet, the most important items were diatoms (19.2%), green algae (19.1%), sand particles (17.1%) and ostracods (12.0%). Blue-green algae and particulate organic matter formed 8.7% and 7.6% of the food, respectively. Each of the remaining items constituted less than 5% of the diet.

In all, 16 genera of diatoms were identified in the diet of which the commonest were *Pleurosigma* and *Amphiprora*. The most common of the 17 genera of green algae were the desmids, *Netrium* and *Penium*, and the filamentous types, *Microspora* and *Geminella*. Of the 12 genera of blue-green algae consumed, the Chroococcales, *Aphanocapsa*, *Holopedium* and *Chroococcus*, and the filamentous forms, *Nodularia*, *Spirulina* and *Anabaena* were the most abundant. Protozoans in the diet were predominantly *Euglena sp.* and *Phacus sp.*, and rotifers were chiefly *Brachionus spp.* Other organisms in the stomachs were unidentified nematodes, ostracods, cladocerans and copepods.

The fishes ingested sand particles measuring 10-650 µm, and ostracods measuring 16-1080 µm; the most frequently taken sizes were 50-100 µm for sand particles, and 250-350 µm for ostracods (Fig. 3).

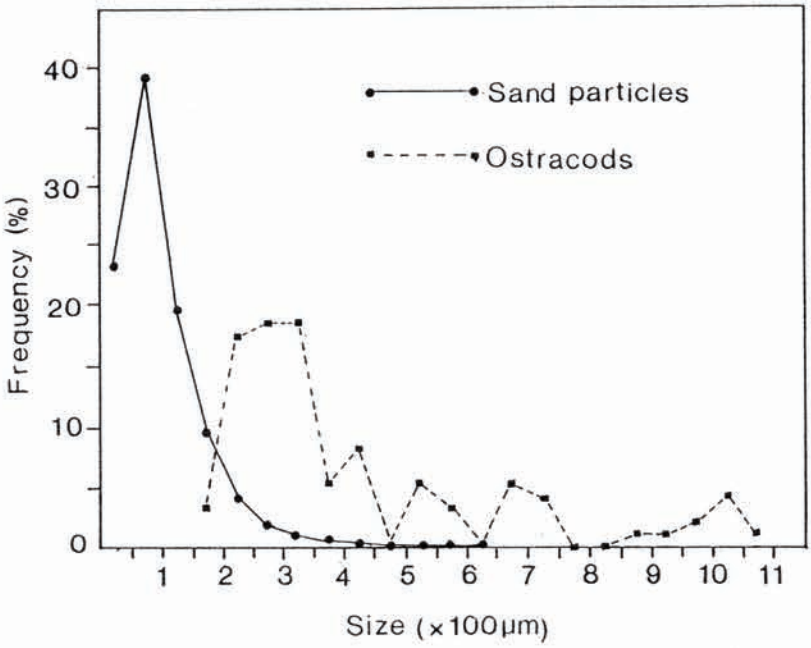

Fig. 3. - Size frequency distribution of sand particles (●—●) and ostracods (■—■) in the stomach of *Liza falcipinnis*.

Daily feeding cycle

Feeding activity, assessed by the fluctuations in the mean index of stomach fullness, occurred between sunrise (06.00 h) and sunset (18.00 h) (Fig. 4). No feeding activity was recorded at night (22.00 h-02.00 h) on any of the three occasions. On 18-19 October, feeding was at its maximum at 10.00 h and stomachs were empty at 18.00, 22.00 and 02.00 h samplings, whereas on both other occasions, the stomachs were fullest a little later at 14.00 h, and there was still food in the stomach at 18.00 h.

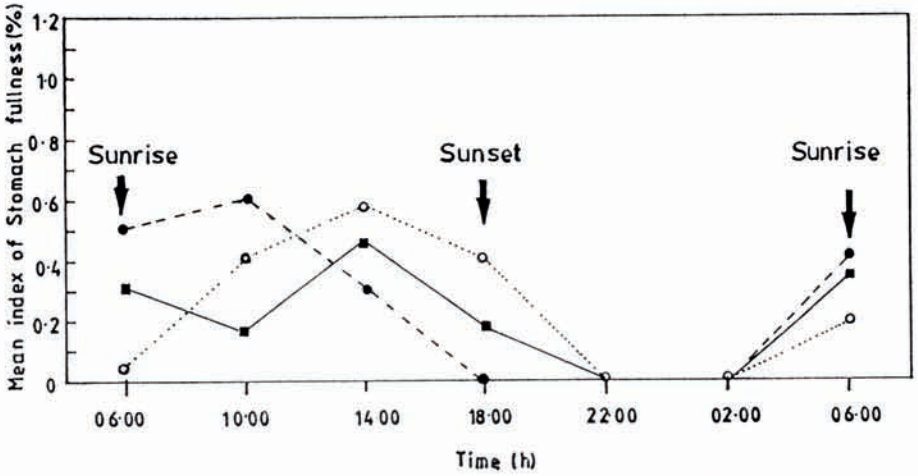

Fig 4. - Daily feeding cycle of juvenile *Liza falcipinnis*. 12-13 October 1991 (■—■); 18-19 October 1991 (●—●); 8-9 November 1991 (○—○).

DISCUSSION

Juvenile *Liza falcipinnis* found in the Fosu Lagoon consumed a wide range of food items comprising microbenthos, meiobenthos, plankton, vertically migrating zooplankton, particulate organic matter and sand particles. This diet is similar to that of juvenile mullet in south-east African estuaries (Blaber and Whitfield, 1977) and the Elmina Lagoon, Ghana (Blay, 1995).

The present results indicate omnivory in the juvenile *L. falcipinnis*, but the largest portion of the diet consisted of plant material, mainly diatoms and green algae. The high incidence of diatoms, particulate organic matter and sand particles in the food is typical of the species in other parts of West Africa (Fagade and Olaniyan, 1973; Payne, 1976; Albaret and Legendre, 1985). However, in the Fosu Lagoon, blue-green algae, bacteria, protozoan flagellates, ostracods, rotifers, fragments of crustaceans and crustacean eggs were also frequently taken. Hence, the fish in this lagoon fed on a wider food range than the populations in the Lagos Lagoon, Nigeria (Fagade and Olaniyan, 1973), the Black Johnson Estuary, Sierra Leone (Payne, 1976) and the Ebrié Lagoon, Côte d'Ivoire (Albaret and Legendre, 1985), although in the former, ostracods, cypris larvae, copepods and fish scales were also eaten. The variations in the food habits of the different populations of *L. falcipinnis* were possibly determined by the abundance and types of food materials available in the habitat (cf Blaber, 1977; Bruslé, 1981).

The presence of sand particles in the stomachs of the sicklefin mullet is consistent with observations on mullets elsewhere (Odum, 1968; Blaber and Whitfield, 1977; Wijeyaratne and Costa, 1986, 1987a, b). The microorganisms associated with sand particles provide nourishment for mullets (Hickling, 1970; Odum, 1970). In addition, sand particles act as a grinding paste for breaking up plant cell walls in the pyloric stomach (Thomson, 1966; Bruslé, 1981). The high proportion of sand in the stomach of the fish might therefore be due to the relatively high composition of diatoms and green algae in the diet.

In the Fosu Lagoon, the sand particles commonly filtered by *L. falcipinnis* measured 50-100 µm. This differs slightly from the 150-200 µm range frequently taken by the fish in the nearby Elmina Lagoon (Blay, 1995). Although this might suggest intraspecific differences in the selection of particles in the two lagoons (e.g., Blaber, 1977), the associated fauna and flora of the sand particles were similar in both water bodies, as indicated by the similarity in the diet of the two populations. Although the largest sand particles filtered occurred in the range 600-650 µm, the food of *L. falcipinnis* included ostracods measuring up to 1080 µm. Odum (1968) pointed out that mullets possess a pharyngeal filtering mechanism which enables them to filter larger food organisms associated with the preferred substratum in their habitat.

A significant increase in the relative gut length with size of fish has been reported in *Crenimugil labrosus* Risso in the United Kingdom (Hickling, 1970) and *Mugil cephalus* L. in the USA (Odum, 1970), and this was attributed to the herbivorous diet of larger fishes. Studies on *M. cephalus* from south-east African estuaries (Blaber, 1977) indicated a similar diet for both small and large individuals in spite of the relative gut length increasing with size of fish. The results obtained for *L. falcipinnis* contradict those referred to above but similar to observations on *M. cephalus* from Sri Lanka (Wijeyaratne and Costa, 1986), as in both populations, the relative gut length and diet did not change significantly with size. These differences could be attributed to variations in the feeding ecology of the different mullet populations.

L. falcipinnis in the Fosu Lagoon showed a marked diurnal feeding activity similar to that shown by *L. macrolepis* (Smith) in the St. Lucia Lake system, South Africa (Blaber, 1976), and four mullet species in the Elmina Lagoon (Blay, 1995). The differences in feeding activity of the Fosu Lagoon fishes on the three sampling days may have been ecologically determined. Odum (1970) reported that tidal activity influences the rate of ingestion by mullet, and De Silva and Perera (1976) observed an increase in food uptake of mullet with salinity. However, tidal variation could not have affected the feeding activity of the mullet in the Fosu Lagoon as it was closed to the sea throughout the year. Furthermore, no noticeable variations in the salinity occurred during the study period that could account for the changes in the feeding activity of the fishes.

Variations in light intensity have also been implicated in the differences observed in the feeding intensity of mullet in a Sri Lankan lagoon (De Silva and Wijeyaratne, 1977). Similarly, changes in light intensity in the Fosu Lagoon may have accounted for the variations in the feeding activity of *L. falcipinnis* on the different sampling days, and the peak feeding of the fish at 10.00 or 14.00 h when insolation was at a maximum.

In conclusion, *L. falcipinnis* in the 'closed' Fosu Lagoon is omnivorous, and its wide food spectrum may be attributed to the high productivity of the lagoon, as also observed for the mullets in the 'open' Elmina Lagoon (Blay, 1995). The species is a diurnal feeder, and the daily variations in its feeding activity may be influenced by changes in the light intensity.

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